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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/188,190	11/10/1998	KATSUNORI KANEKO	1472-177P	4015

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BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747

EXAMINER
NGUYEN, TU MINH

ART UNIT	PAPER NUMBER
3748	26

DATE MAILED: 10/10/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.	Applicant(s)
09/188,190	Kaneko et al.
Examiner	**Art Unit**
Tu M. Nguyen	3748

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on *Oct 2, 2002* .

2a) ☒ This action is **FINAL.** 2b) ☐ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

Disposition of Claims

4) ☒ Claim(s) *1-14* is/are pending in the application.

4a) Of the above, claim(s) _____ is/are withdrawn from consideration.

5) ☐ Claim(s) _____ is/are allowed.

6) ☒ Claim(s) *1-14* is/are rejected.

7) ☐ Claim(s) _____ is/are objected to.

8) ☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

9) ☐ The specification is objected to by the Examiner.

10) ☒ The drawing(s) filed on *Oct 2, 2002* is/are a) ☒ accepted or b) ☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13) ☒ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a) ☒ All b) ☐ Some* c) ☐ None of:

1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

*See the attached detailed Office action for a list of the certified copies not received.

14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

a) ☐ The translation of the foreign language provisional application has been received.

15) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s). _____
4) ☐ Interview Summary (PTO-413) Paper No(s). _____
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other:

DETAILED ACTION

1. An Applicant's Request for Reconsideration filed on October 2, 2002 has been entered. Overall, claims 1-14 are pending in this application.

Drawings

2. The formal drawing of Figure 5 filed on October 2, 2002 has been approved for entry.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office Action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1 and 8-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hepburn et al. (U.S. Patent 5,974,788) in view of Araki et al. (U.S. Patent 5,850,735).

Re claim 1, as shown in Figure 1, Hepburn et al. disclose an exhaust gas purifying apparatus of an internal combustion engine, comprising:

- exhaust gas purifying means (32), having a function of a three-way catalyst (the purifying means (32) of Hepburn removes HC, CO, and NO_x in the exhaust gas at stoichiometric or slightly

rich condition (lines 13-18 and 39-48 of column 1)) provided in an exhaust passage of the internal combustion engine, for absorbing NO_x in an exhaust gas when an air-fuel ratio of the exhaust gas is lean, and means (20, 16) for releasing or reducing the absorbed NO_x when an oxygen concentration of the exhaust gas is reduced;

- a light-off catalyst (26) provided upstream of the exhaust gas purifying means in the exhaust passage, the light-off catalyst having a lower O_2 storage capability than the exhaust gas purifying means (lines 48-50 of column 4), the light-off catalyst and the exhaust gas purifying means are in an exhaust passage in series so that all the exhaust gas from the engine passes through both the light-off catalyst and the exhaust gas purifying means regardless of the engine operation modes; and

- control means (20, 16) for controlling the air-fuel ratio of the exhaust gas so that an atmosphere having a reduced oxygen concentration is produced around the exhaust gas purifying means (32) when an NO_x conversion efficiency of the exhaust gas purifying means is decreased,

wherein a substance (SO_x) decreasing the NO_x conversion efficiency of the exhaust gas purifying means is released during the operation of the control means (as indicated on lines 23-25 of column 1 and lines 64 of column 2 to line 5 of column 3, during a lean mode in the apparatus of Hepburn et al., in addition to NO_x, SO_x also accumulates in the exhaust gas purifying means (32), occupying the storage sites that would be otherwise used to store NO_x. This clearly causes a reduction in NO_x conversion efficiency of the purifying means (32). Thus, to restore the NO_x conversion efficiency of the purifying means, the SO_x stored in the purifying means (32) are

occasionally purged and "burned" off by modulating the amplitude of the air-fuel ratio at a properly chosen frequency to create a rich break-through of the light-off catalyst. In this way, an atmosphere having large unburned HC and CO concentration is produced around the exhaust gas purifying means for the effective purging and combustion of SO_x).

Hepburn et al., however, fail to specifically disclose that the substance (SO_x) released during the operation of the control means is converted by the function of the three-way catalyst of the exhaust gas purifying means.

Araki et al. teach a method for purifying exhaust gas, that clearly describes in detail the mechanism of absorption and desorption of sulfur species in a SO_x absorbent (5) (lines 54-57 of column 6, lines 5-57 of column 7, and lines 8-27 of column 17). They teach that the mechanism of purifying SO_x in the exhaust gas is similar to the three-way catalytic purification of NO_x in which the harmful emissions of NO_x, HC, and CO in the exhaust gas are eliminated. The only difference is the higher temperature required for the SO_x purging. During a lean engine cycle, sulfur compounds in the exhaust gas are oxidized and absorbed by an absorbent layer of the SO_x absorbent in the form of a SO_4 sulfate. To purge the sulfate from the SO_x absorbent, the engine operation is switched to fuel rich to generate a reductant rich environment that contains excess unburned HC and CO. In this reductant rich environment, the temperature of the SO_x absorbent is substantially raised by the oxidization of the excess HC and CO. The high temperature induces the desorption of SO_4 from the absorbent layer, which is then reduced by the excess HC and CO to become either SO_2 (gaseous state) or SO_3 (solid state). During the desorption of SO_4, Araki et

al. selectively raise the exhaust gas to a temperature above a predetermined value and lower the oxygen content in the exhaust gas to minimize the conversion of SO_4 to SO_3 which is in a solid state (see Figures 2 and 3). In this way, more sulfur compounds (SO_2) in the gaseous state are transformed from SO_4; and an amount of particulate matters (in the form of SO_3) released into the atmosphere can be maintained at a low lever. Thus, the SO_x in the exhaust gas in Araki et al. is converted by a three-way catalytic function of the SO_x absorbent, in which the three harmful emissions of SO_x, HC, and CO in the exhaust gas are eliminated. It would have been obvious to one having ordinary skill in the art at the time of the invention was made, to have utilized the method taught by Araki et al. in the apparatus of Hepburn et al., since the use thereof would have minimized the generation of sulfur particulate matters which can clog up the exhaust gas purifying means.

Re claim 8, in the modified exhaust gas purifying apparatus of Hepburn et al., the internal combustion engine is a spark ignition type four-cycle engine that operates on the four-stroke cycle consisting of a suction stroke, compression stroke, combustion/expansion stroke, and exhaust stroke.

Re claim 9, in the modified exhaust gas purifying apparatus of Hepburn et al., the internal combustion engine is an in-cylinder injection type engine in which fuel is directly injected into a combustion chamber (lines 3-6 of column 2).

Re claims 10 and 11, the single catalyst of the exhaust gas purifying means (32) in the modified exhaust gas purifying apparatus of Hepburn et al. functions as a three-way catalyst.

Re claim 12, the light-off catalyst (26) in the modified exhaust gas purifying apparatus of Hepburn et al. includes a single catalyst that functions as a three-way catalyst (lines 12-13 of column 2).

Re claim 13, the exhaust gas purifying means (32) in the modified exhaust gas purifying apparatus of Hepburn et al. functions also as an NO_x catalyst.

Re claim 14, the light-off catalyst (26) in the modified exhaust gas purifying apparatus of Hepburn et al. also functions as a SO_x catalyst to oxidize and convert SO_2 in the exhaust gas to a sulfate which can be absorbed by the exhaust gas purifying means.

5. Claims 3 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hepburn et al. in view of Araki et al. as applied to claim 1 above, and further in view of design choice.

The modified exhaust gas purifying apparatus of Hepburn et al. discloses the invention as cited above, however, fails to disclose that an amount of oxygen absorbed on the light-off catalyst is not greater than about 150 cc per one-liter volume of the catalyst when measured by an oxygen pulse method and that an oxygen component stored in the light-off catalyst is not greater than about 25 gr per one-liter volume of the catalyst.

One having ordinary skill in the art of exhaust emission control would have recognized that the specification of the maximum volumetric or weighted amount of oxygen absorbed in a light-off catalyst would be a function of many variables such as the size of the light-off catalyst, engine size, engine operating conditions (load, speed, etc), air and fuel properties, capacity and size of a main catalyst, etc. Moreover, there is nothing in the record which establishes that the

claimed maximum volumetric or weighted amount of oxygen absorbed in a light-off catalyst presents a novel of unexpected result (See *In re Kuhle*, 526 F.2d 553, 188 USPQ 7 (CCPA 1975)).

6. Claims 2 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hepburn et al. in view of Takeshima (U.S. Patent 5,448,887).

Re claim 2, as shown in Figure 1, Hepburn et al. disclose an exhaust gas purifying apparatus of an internal combustion engine, comprising:

- exhaust gas purifying means (32), provided in an exhaust passage of the internal combustion engine, for absorbing NO_x in an exhaust gas when an air-fuel ratio of the exhaust gas is lean, and means (20, 16) for releasing or reducing the absorbed NO_x when an oxygen concentration of the exhaust gas is reduced;

- a light-off catalyst (26) provided upstream of the exhaust gas purifying means in the exhaust passage, the light-off catalyst having a lower O_2 storage capability than the exhaust gas purifying means (lines 48-50 of column 4), the light-off catalyst and the exhaust gas purifying means are in an exhaust passage in series so that all the exhaust gas from the engine passes through both the light-off catalyst and the exhaust gas purifying means regardless of the engine operation modes; and

- control means (20) for controlling the air-fuel ratio of the exhaust gas so that an atmosphere having a reduced oxygen concentration is produced around the exhaust gas purifying means (32) when an NO_x conversion efficiency of the exhaust gas purifying means is decreased,

wherein a substance (SO_x) decreasing the NO_x conversion efficiency of the exhaust gas purifying means is released from the exhaust gas purifying means during the operation of the control means by CO break-through in the light-off catalyst.

As indicated on lines 23-25 of column 1 and lines 64 of column 2 to line 5 of column 3, during a lean mode in the apparatus of Hepburn et al., in addition to NO_x, SO_x also accumulates in the exhaust gas purifying means (32), occupying the storage sites that would be otherwise used to store NO_x. This clearly causes a reduction in NO_x conversion efficiency of the purifying means (32). Thus, to restore the NO_x conversion efficiency of the purifying means, the SO_x stored in the purifying means (32) are occasionally purged and "burned" off by modulating the amplitude of the air-fuel ratio at a properly chosen frequency to create a rich break-through of the light-off catalyst. In this way, an atmosphere having large unburned HC and CO concentration is produced around the exhaust gas purifying means for the effective purging and combustion of SO_x.

Hepburn et al., however, fail to disclose that the light-off catalyst has a constant HC conversion efficiency.

As shown in Figures 1 and 2, Takeshima teaches that the HC conversion efficiency for an upstream three-way catalyst (12) is relatively high and constant for an exhaust gas with a stoichiometric or fuel lean air-fuel ratio. The HC conversion efficiency, however, is relatively low and also constant for an exhaust gas with a fuel rich air-fuel ratio. It would have been obvious to one having ordinary skill in the art at the time of the invention was made, to have utilized the

teachings of Takeshima in the apparatus of Hepburn et al., since the use thereof would have provided a means to control the engine air-fuel ratio for the effective purifying of exhaust gas.

Re claim 5, in the modified apparatus of Hepburn et al., the light-off catalyst (26) has an oxygen storage capability of a first value; and the exhaust gas purifying means (32) having a function of a three-way catalyst has an oxygen storage of a second value which is greater than the first value (lines 48-50 of column 4).

7. Claims 6 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hepburn et al. in view of Takeshima as applied to claim 5 above, and further in view of design choice.

The modified exhaust gas purifying apparatus of Hepburn et al. discloses the invention as cited above, however, fails to disclose that an amount of oxygen absorbed on the exhaust gas purifying means having a function of a three-way light-off catalyst is not greater than about 150 cc per one-liter volume of the catalyst when measured by an oxygen pulse method and that an oxygen component stored in the exhaust gas purifying means having a function of a three-way light-off catalyst is not greater than about 25 gr per one-liter volume of the catalyst.

One having ordinary skill in the art of exhaust emission control would have recognized that the specification of the maximum volumetric or weighted amount of oxygen absorbed in the exhaust gas purifying means would be a function of many variables such as the size of the exhaust gas purifying means, engine size, engine operating conditions (load, speed, etc), air and fuel properties, capacity and size of a main catalyst, etc. Moreover, there is nothing in the record which establishes that the claimed maximum volumetric or weighted amount of oxygen absorbed

in the exhaust gas purifying means presents a novel of unexpected result (See *In re Kuhle*, 526 F.2d 553, 188 USPQ 7 (CCPA 1975)).

Response to Arguments

8. Applicant's arguments with respect to the references applied in the previous Office Action have been fully considered but they are not persuasive.

In response to applicant's argument that Hepburn et al. fail to disclose or suggest that the purifying means (32) has a function of a three-way catalyst (page 3 of Applicant's Amendment), the examiner respectfully disagrees. This argument has been responded in detail in an advisory action (Paper No. 21) mailed on March 28, 2002. Thus, the reply presented below is substantially repeated.

The definition of a three-way catalyst is a device having an ability to eliminate the three harmful emissions, namely NOx, HC, and CO, in the exhaust gas when the exhaust gas is at stoichiometric or fuel rich condition. The purifying means (32) of Hepburn et al. stores the NOx from the exhaust gas during a fuel lean operation; and releases and reduces the stored NOx during a stoichiometric or fuel rich operation (lines 13-18 of column 1). During the reduction of NOx, the HC and CO in the exhaust gas are chemically reacted with NOx to form the benign products of water, nitrogen, and carbon dioxide. Therefore, the purifying means of Hepburn et al. demonstrates the ability to eliminate NOx, HC, and CO in the exhaust gas when the exhaust gas is at stoichiometric or fuel rich condition and thus, clearly has a function of a three-way catalyst.

In response to applicant's argument that the statement "This (the absorbing of SOx in the purifying means (32)) clearly causes a reduction in NOx conversion efficiency of the purifying means (32)" is not understood because the examiner is relying only on a "possibility" or a "probability" (page 4 of Applicant's Amendment), the examiner again respectfully disagrees. Again, this argument has been responded in detail in Paper No. 21; and thus, the following reply is repeated for convenience. The aforementioned statement made by the examiner is fully supported by the disclosure in Hepburn et al. As stated on lines 23-25 of column 1 and lines 64-67 of column 2, Hepburn et al. clearly state that sulfur is a contaminant; and an accumulation of sulfur in a NOx trap causes a decrease in the NOx trapping efficiency and the ultimate conversion of NOx within the trap.

In response to applicant's argument that Araki et al. fail to teach "the mechanism of purifying SO_x in the exhaust gas is similar to the three-way catalytic purification of NO_x in which the harmful emissions of NO_x, HC, and CO in the exhaust gas are eliminated" (page 8 of Applicant's Amendment), the examiner again respectfully disagrees. As outlined on pages 4 and 5 above, the mechanism of absorption and desorption of sulfur species in a SO_x absorbent (5) of Araki et al. is explained in detail. The discussion on these pages shows that in Araki et al., the SO_x in the exhaust gas is converted in the chemical reactions in which the two harmful emissions HC and CO in the exhaust gas are also purified. Those with ordinary skill in the art would immediately recognize that this is similar to the three-way catalytic purification of NO_x in which the harmful emissions of NO_x, HC, and CO in the exhaust gas are purified.

In response to applicant's argument that it is improper to use "design choice" in the 103(a) rejections of dependent claims 3, 4, 6, and 7 (pages 6, 7, 9, and 10 of Applicant's Amendment), the examiner again respectfully disagrees. As has been clearly shown, the upstream light-off catalyst in Hepburn et al. has a lower oxygen storage capacity than that of the downstream purifying means, which satisfies an important limitation in the pending application. Clearly, Hepburn et al. know the exact oxygen storage capacity of the light-off catalyst and the purifying means. Given the required and fixed (emphasis added) oxygen storage capacity of the light-off catalyst, it is obvious to those with ordinary skill in the art that the limitation of "the specified volumetric or mass of oxygen storage per unit volume of the catalyst" (emphasis added) is merely a design choice which is clearly a function of the size of the light-off catalyst. Since the oxygen storage capacity of the upstream light-off catalyst has to be constant, the specified volumetric or mass of oxygen storage per unit volume for a smaller catalyst should obviously be greater than those for a larger catalyst.

Conclusion

9. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after

the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Communication

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Examiner Tu Nguyen whose telephone number is (703) 308-2833.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mr. Thomas E. Denion, can be reached on (703) 308-2623. The fax phone number for this group is (703) 308-7763.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-1148.

Tu M. Nguyen

TMN

October 9, 2002

Tu M. Nguyen

Patent Examiner

Art Unit 3748

THOMAS DENION
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 3700